ATTACHMENT 2

Specification For A Steerable Antenna

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1.0 Scope

The purpose of this specification is to document the requirements for a steerable tracking antenna system for the Radio Frequency and Telemetry Station (RFTS). The antenna will be utilized as part of the overall RFTS which is used to checkout/test, monitor, troubleshoot and provide launch support of spacecraft and launch vehicle radio frequency (RF) communication systems.

2.0 Applicable Documents

The following documents form a part of this specification to the extent specified herein. When this document is used for procurement, including solicitations, or is added to an existing contract, the specific revision levels, amendments, and approval dates of said documents shall be specified in an attachment to the Solicitation/Statement of Work/Contract.

When the requirement of this specification and those of any applicable reference specification conflict, the requirement of this specification shall govern.

Deviations from this specification or any specifications applicable to this procurement are not authorized except by formal contract modification.

2.1 Government Publications

National Aeronautics and Space Administration (NASA)

KSC-DE-512-SM	Facility, System, and Equipment General Design Requirements
KSC-E-166	Electrical Ground Support Equipment Fabrication, Specification for
KSC-STD-E-0012	Facility Grounding and Lightening Protection, Standard for
KSC-STD-F-004	Fire Protection Design, Standard for
NASA-STD-8719.11	Safety Standard for Fire Protection
NASA-STD-5008	Protective Coating of Carbon Steel, Stainless Steel, and Aluminum on Launch Structures, Facilities, and Ground Support Equipment
NPR 8715.3	NASA Safety Manual

(Copies of specifications, standards, drawings, and publications required by vendors in connection with specified procurement functions should be obtained from or as directed by the contracting officer)

2.2 Non-Governmental

NEMA 250-2008	National Electrical Manufacturers Association, Enclosures for Electrical Equipment (1000 Volts Maximum)
NFPA 70	National Fire Protection Association, National Electrical Code

3.0 Requirements

This section defines the requirements for a steerable tracking antenna system. The steerable tracking antenna system shall be comprised of two subsystems: 1) Steerable Antenna Pedestal and 2) the Antenna Control System. The steerable tracking antenna system is to provide integrated RF downlink and RF command uplink signals to/from

fixed (launch pad) and moving targets (ascending spacecraft/launch vehicles) in a full duplex mode over the 1.7 to 2.4GHz frequency band.

The steerable antenna pedestal is located remotely from its controlling system. The antenna pedestal will be located outdoors and not under the cover of a radome. The antenna pedestal will consist of a pedestal (motors, digital servo amps, encoder/decoders), supporting electronic enclosure(s), RF feed, parabolic reflector, and the required electrical/mechanical/communication interfaces. An elevation over azimuth positioner is to be used to track objects in motion. The remote location where the pedestal is located already provides the pedestal mechanical mounting interface, communications and power supply. The steerable tracking antenna system should be capable of operating to the loads and environment which are described later in this specification.

The control system shall be located remotely from the antenna pedestal/positioner. The antenna control system shall provide an operator the interface to control and status the antenna positioner. Manual and automatic modes of operation are required. The control system shall allow the operator to manually point the antenna to a point in space or to manually track an object in motion. The control system shall allow the automatic steering of the antenna pedestal to a point in space or to automatically follow an object in motion.

3.1 Radio Frequency Requirements

The antenna shall have a Voltage Standing Wave Ratio (VSWR) of 1.5:1.

The antenna side lobes shall be -20dB or lower than the main lobe.

The antenna G/T measured at an elevation of 10º and 2.0GHz shall be a minimum of 12dB/ºK

3.1.1 Transmit

The antenna shall be capable of transmitting microwave signals.

3.1.2 Transmit Frequency Band

The antenna shall be capable of transmitting microwave signals in the frequency band from 1.7GHz to 2.54GHz.

3.1.3 Transmit Radiating Power

The antenna shall be capable of transmitting at power levels of at least ten (10) watts.

3.1.4 Transmit Gain

The antenna transmit gain shall be at least 31dB at 2.0GHz

3.1.5 Transmit Polarization

Transmit polarization shall be both linear and circular. For linear, the transmit polarization can be either horizontal or vertical. If circular, the transmit polarization must be the same as the receive polarization and shall be user selectable as right or left hand.

3.1.6 Receive

The antenna shall be capable of receiving multiple microwave signals simultaneously.

3.1.7 Receive Frequency Band

The antenna shall be capable of receiving microwave signals in the frequency band from 1.7GHz to 2.54GHz frequency band to be received and rejects signals outside of this band.

3.1.8 Receive Low Noise Amplifier (LNA)

The antenna shall implement a LNA in the receive path as close as possible to the receive feed port.

3.1.9 Receive LNA Gain

The receive LNA shall have a gain of 30dB minimum.

3.1.10 Receive LNA Noise Figure
The receive LNA shall have a noise figure less than 1dB.

3.1.11 Receive Polarization
Receive polarization shall be both linear and circular. If linear, the receive polarization can be either horizontal or vertical. If circular, the receive polarization must be the same as the transmit polarization and shall be user selectable as right or left hand.

3.2 Electrical Requirements
All electrical equipment shall be UL listed.

All outdoor electrical enclosure(s) and devices shall be rated NEMA 4X.

All outdoor conduit shall be rigid steel conduit and be galvanized by hot-dip process including all fittings.

3.2.1 Antenna Pedestal and Positioner Subsystem Power
Installation of electrical power to the pedestal/positioner shall comply with the latest National Electrical Code.

The remote antenna pedestal and positioner subsystem shall use external provided power of 120VAC, ±5%, single phase, 57 to 63Hz. Transient current events should not exceed 30 Amperes.

The antenna pedestal/positioner shall include a grounding tie point and suitable cable to be bonded to the existing grounding system. Grounding for the antenna shall comply with KSC-STD-0012 along with manufacturer's instructions.

The antenna pedestal and positioner subsystem shall provide a fused or circuit breaker service panels to protect the input power source to the pedestal/positioner. The fuses or circuit breakers shall be field replaceable components.

3.2.2 Antenna Control Subsystem Power
The antenna control subsystem shall use external power provided by the existing RFTS equipment racks; 120VAC, ±5%, single phase, 57 to 63Hz. Transient current events should not exceed 20 Amperes. The antenna control system shall include a grounding tie point and suitable cable to be bonded to the existing grounding system.

3.3 RF and Communications Cabling and Connections

3.3.1 RF Interface Cabling and Connections
The vendor shall supply all RF cables between the antenna pedestal positioner and the existing RFTS heliax cabling system. The connector interfaces on the pedestal shall be type N female. Every effort shall be made to minimize the distance of the cable utilized between the pedestal interface and the existing cable interface. There shall be no adapters utilized to match cable types. All RF cabling and connections shall be protected or waterproofed with 3M cold shrink, weatherproof tape or equivalent. Cables and connectors shall utilize materials which meet the life cycle duration of the positioner/pedestal and the environmental conditions specified in Table 2.

3.3.2 Communications Cabling and Connections
Optical cabling is provided between the antenna platform and the RFTS equipment racks. On the platform, the vendor shall supply all communications cables between the antenna pedestal/positioner and the existing RFTS optical patch panel. Media conversion between electrical/optical and optical/electrical domains is acceptable and shall be contained within the antenna pedestal/positioner or supporting electronic enclosure(s). In the RFTS the vendor shall supply all communications cables between the RFTS optical patch panel system and the antenna control system. Communications cables and connectors shall utilize materials which meet the life cycle duration of the positioner/pedestal and the environmental conditions specified in Table 2. All antenna pedestal/positioner

communications cabling and connections shall be protected or waterproofed with 3M cold shrink, weatherproof tape or equivalent.

3.3.3 Cable Management

A cable management system shall be implemented to secure all cabling while the antenna pedestal/positioner is in motion.

3.4 Antenna Pedestal/Positioner - Mechanical/Physical and Performance Requirements

3.4.1 Antenna Size and Shape

The antenna reflector shall be a maximum of 2.4 Meters (8 Foot) axially symmetric parabolic surface.

3.4.2 Antenna Pedestal/Positioner Size and Weight

The total antenna system maximum weight shall not exceed 498.96.Kilograms (1100 pounds). This weight includes: the antenna, RF feed and any feed support arms, additional electronic enclosure(s), and antenna pedestal/positioner and balance weights.

The antenna pedestal/positioner maximum height shall not exceed 3 Meters (9.84 Feet). This height does not include the antenna, RF feed and any feed support arms).

3.4.3 Antenna Pedestal/Positioner Performance

Table 1 defines the minimum performance specifications for the antenna pedestal/positioner.

PARAMETERS			UNITS	VALUES
Velocity			Deg/sec	10
Peak Acceleration			Deg/sec^2	15
Limit-to-Limit Travel	Azimuth		Deg	0 to 350
	Elevation	Down	Deg	-5
		Up	Deg	90

Table 1: Antenna Pedestal/Positioner Performance Parameters

3.4.4 Mechanical Stops and Locks

The antenna pedestal/positioner shall be equipped with two “stow-lock” pin assemblies, one for each axis and with mechanical stop strikers and a shock absorbing mechanism.

The stop strikers and the shock absorbing mechanism unit shall arrest axis motion and prevent physical damage to the antenna or antenna platform, in case of a software control or electrical limits malfunction.

3.4.5 Pedestal/Positioner Indicators and Markings

The antenna pedestal/positioner shall provide indicators for manual leveling.

The antenna pedestal/positioner shall provide an external scale on the azimuth and elevation mechanisms/casings, with graduation marks every one (1) degree to provide readout of angles and to show the relative position of the positioner mounting bolts with respect to the azimuth axis zero reference point.

All access panels and pedestal/positioner interfaces shall be clearly marked with suitable labels or engravings.

3.4.6 Pedestal/Positioner and Support Enclosure(s)

The anticipated operational life cycle duration of the antenna system shall be a minimum of ten (10) years.

The antenna pedestal/positioner and any supporting enclosure(s) shall operate in an outdoor environment without a radome without sustaining any damage or degradation of performance. See section 3.5 for environmental requirements.

All metallic materials such as, but not limited to antenna fittings, anchors, bolts, boxes, clamps, fittings, nuts, pins, rods, shims, washers, shall be hot-dip galvanized.

The antenna pedestal/positioner shall include access panels to allow access to the internal components for maintenance. All internal replaceable components shall be accessible through access covers.

The antenna pedestal/positioner and any supporting enclosure(s) shall be completely weatherproof.

The antenna pedestal/positioner and any supporting enclosure(s) shall be sealed to keep out blowing sand, dust, salt and rain.

All castings shall serve as basic structural members as well as the weatherproof exterior.

The antenna pedestal/positioner and any supporting enclosure(s) shall provide fittings capable of receiving a dry air or nitrogen purge supply.

The antenna pedestal/positioner and any supporting enclosure(s) shall be corrosion protected.

3.5 Antenna Pedestal/Positioner Environmental Requirements

The antenna pedestal/positioner and support enclosure(s), with the antenna reflector and RF feed attached, shall be capable of withstanding the environmental conditions listed below in Table 2 without sustaining any damage or degradation.

Environment Description	High wind, high salt content, tropical marine environment
Temperature Range	-12 ºC (10ºF) to 60ºC (140ºF)
Relative Humidity Range	Up to 95%
Wind Speed (Operating)	0 - 40 mph
Wind Speed (Storage Max.)	Up to 140 mph

Table 2: Antenna Pedestal/Positioner Environmental Parameters

3.6 Control System

A remote antenna control system shall be provided in order to operate the antenna pedestal/positioner. The antenna control system shall provide the capability to move the positioner by manual and automated feedback mechanisms.

3.6.1 Control System Interface

3.6.1.1 Displays

Displays shall be provided to indicate the antenna system current mode of operation.

Displays shall be provided which indicate the antenna pedestal/positioner current position.

Displays shall be provided which indicate the antenna control system and pedestal/positioner current tracking mode, manual or automatic.

Displays shall be provided which indicate the antenna control system and pedestal/positioner current health and status information.

Displays shall provide indicators of the operating state of the antenna pedestal/positioner locking mechanisms.

Displays shall be provided to allow for system configuration changes.

3.6.1.2 User Interfaces

The antenna control system shall provide a keyboard for data entry of alphanumeric information.

For manual tracking, the antenna control system shall provide a joystick, trackball or equivalent user interface to direct the antenna pedestal/positioner.

3.6.2 Control System

The antenna control system shall operate remotely from the antenna pedestal/positioner.

The antenna control system shall provide both manual and automatic control of the pedestal/positioner.

While in automatic tracking mode, the antenna control system shall be capable of being overridden by the operator and manually steered.

The antenna control system shall have the capability to be switched back to automatic tracking mode if initially started in manual mode of tracking.

The antenna control system (CPU, storage, communication interfaces) shall be capable of being installed in standard 19 inch electrical equipment cabinets. User interfaces (displays, keyboards, joysticks, consoles) shall be capable of being supported up to 30 feet away from the main control system. Standard electrical equipment power (120 VAC, 20 or 30 Amp, single phase) will be provided within the cabinet.

Antenna control system components (servo amps, encoders/decoders) which are required to be co-located with the pedestal/positioner shall meet the electrical, mechanical, construction and environmental requirements stated previously.

The antenna control system shall provide the capability to command and control the pedestal/positioner safety locking mechanisms.

The antenna control system shall provide the capability to select the antenna polarization configuration.

The antenna control system shall provide startup built-in self tests and diagnostic routines to notify the operator of the system health/status and any hardware failure modes.

The antenna control system shall provide for the logging of system commands and events. At a minimum, logging shall consist of a date and timestamp, and the identification of the system command or event.

The antenna control system shall provide the capability to tune, test, calibrate, measure and report the pedestal/positioner azimuth and elevation axes.

The antenna control system shall provide the capability to configure the control system operating parameters.

The antenna control system shall provide the capability to store and recall the control system operating parameters and logs.

3.6.3 Antenna Control System Communications

The antenna control system communications between the control system and the pedestal/positioner shall be Ethernet utilizing the TCP/IP protocol suite.

The physical interface between the antenna control system and the RFTS communications cabling system shall be optical and terminated with LC type connectors.

The physical interface between the antenna pedestal/positioner controls and the RFTS communications cabling system shall be optical and terminated with LC type connectors.